Natural and Nature-Based Features in the USACE North Atlantic Coast Comprehensive Study

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PIANC WwN Workshop

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US Army Corps of Engineers
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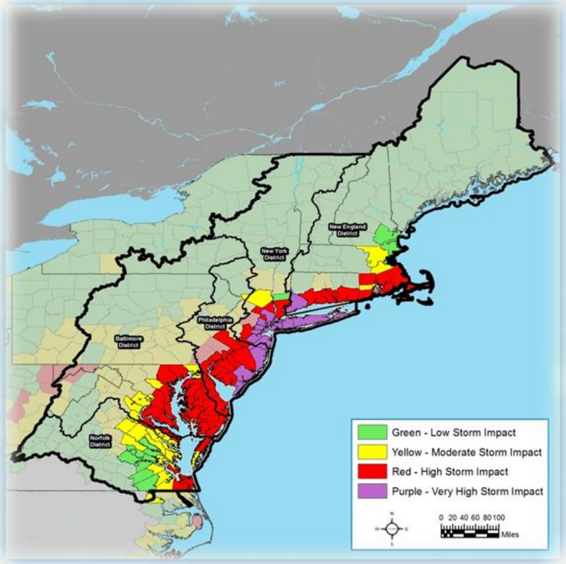
Hurricane Sandy

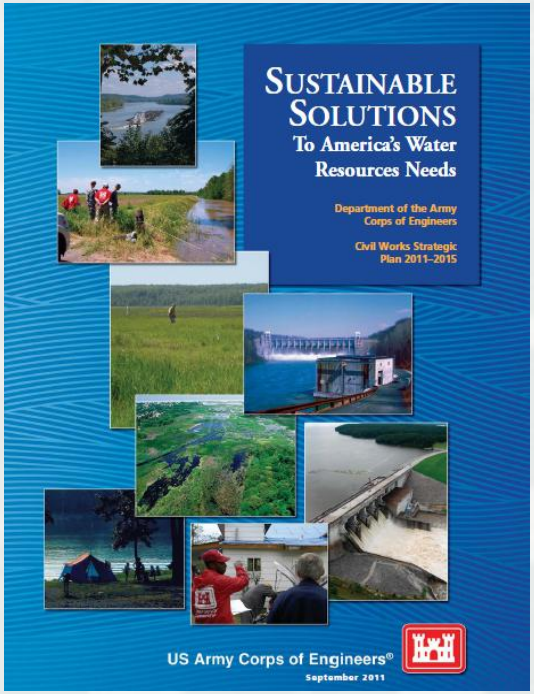
Storm Impacts and Damages:

- **Human**
  - 286 people killed (159 in the US)
  - 500,000 people affected by mandatory evacuations
  - 20,000 people required temporary shelter
  - Extensive community dislocations – continuing today in some areas
- **Economic**
  - $65B in damages in the U.S.
  - 26 states affected (10 states and D.C are in the NACCS study area)
  - 650,000 houses damaged or destroyed



In the Context of Coastal Resilience…

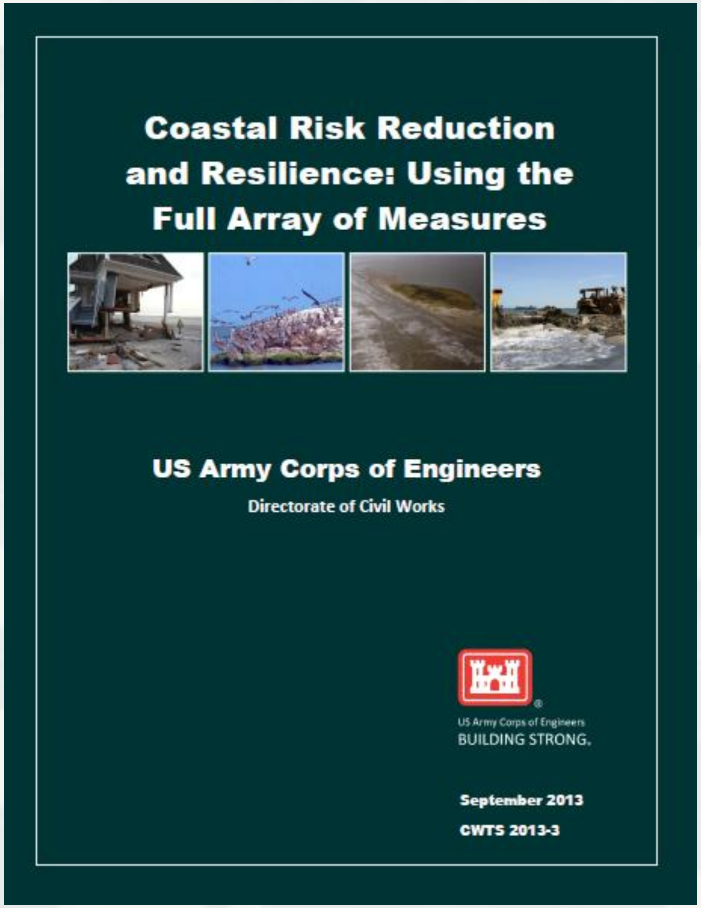
- What opportunities are there for achieving better alignment of natural and engineered systems?
  - ► Can improved alignment reduce risks to life and property?
  - ► What additional services can be produced?
  - ► What are the science and engineering needs in order to achieve better alignment?



Sustainable Solutions Vision: "Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation's water resources challenges."

Systems: Coastal Risk Reduction and Resilience

*"The USACE planning approach supports an **integrated approach** to reducing coastal risks and increasing human and ecosystem community resilience through a combination of **natural, nature-based, non-structural and structural measures**. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short- and long-term. It also considers the **full range of environmental and social benefits** produced by the component features."*


Coastal Risk Reduction and Resilience: Using the Full Array of Measures

US Army Corps of Engineers
Directorate of Civil Works

US Army Corps of Engineers
BUILDING STRONG.

September 2013
CWTS 2013-3

UNCLASSIFIED / FOUO

Natural and Nature-Based Infrastructure at a Glance

GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:
STORM INTENSITY, TRACK, AND FORWARD SPEED, AND SURROUNDING LOCAL BATHYMETRY AND TOPOGRAPHY

Dunes and Beaches

Benefits/Processes

Break offshore waves

Attenuate wave energy

Slow inland water transfer

Performance Factors

Berm height and width

Beach Slope

Sediment grain size and supply

Dune height, crest, width

Presence of vegetation

Vegetated Features: Salt Marshes, Wetlands, Submerged Aquatic Vegetation (SAV)

Benefits/Processes

Break offshore waves

Attenuate wave energy

Slow inland water transfer

Increase infiltration

Performance Factors

Marsh, wetland, or SAV elevation and continuity

Vegetation type and density

Oyster and Coral Reefs

Benefits/Processes

Break offshore waves

Attenuate wave energy

Slow inland water transfer

Performance Factors

Reef width, elevation and roughness

Barrier Islands

Benefits/Processes

Wave attenuation and/or dissipation

Sediment stabilization

Performance Factors

Island elevation, length, and width

Land cover

Breach susceptibility

Proximity to mainland shore

Maritime Forests/Shrub Communities

Benefits/Processes

Wave attenuation and/or dissipation

Shoreline erosion stabilization

Soil retention

Performance Factors

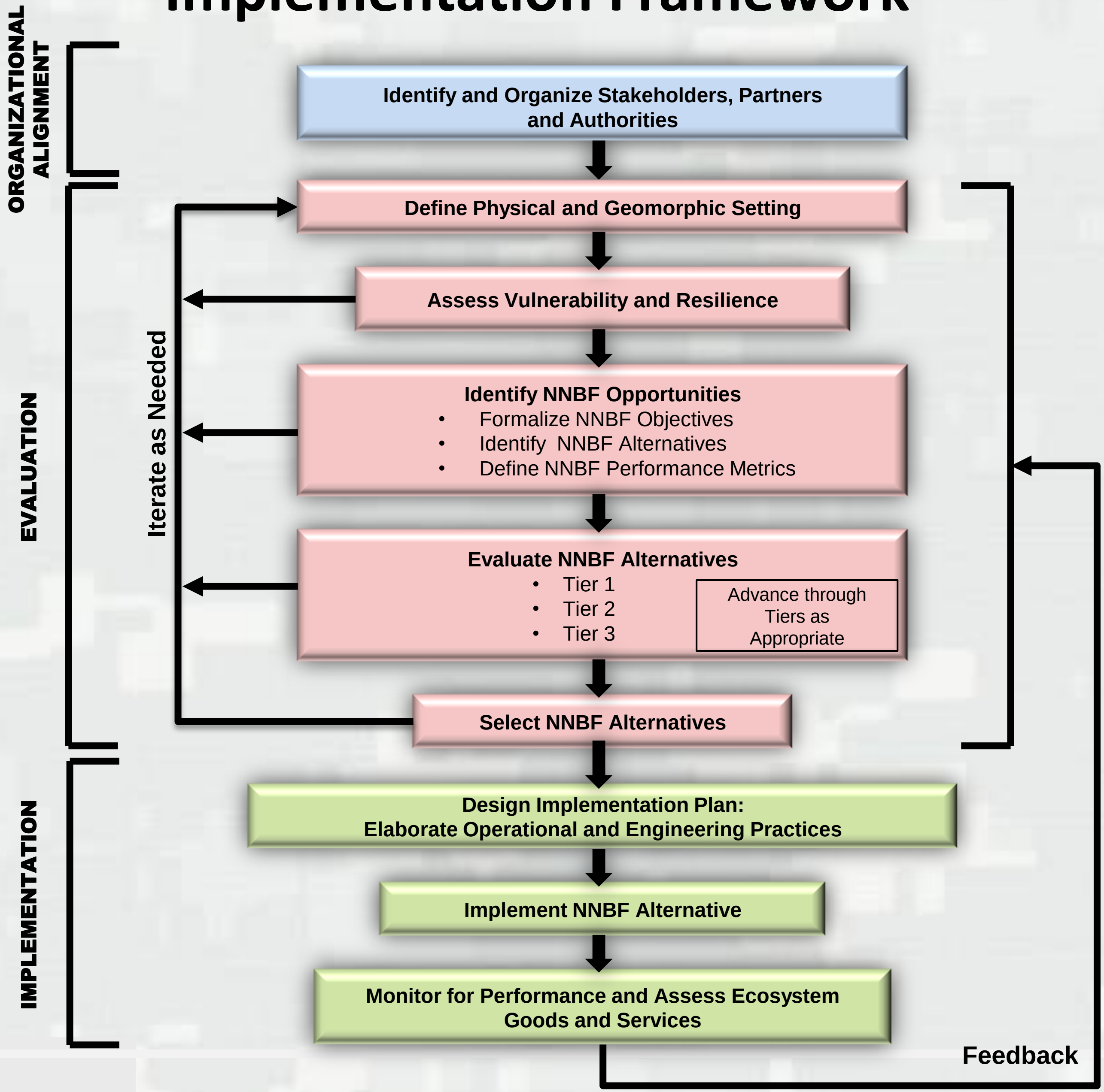
Vegetation height and density

Forest dimension

Sediment composition

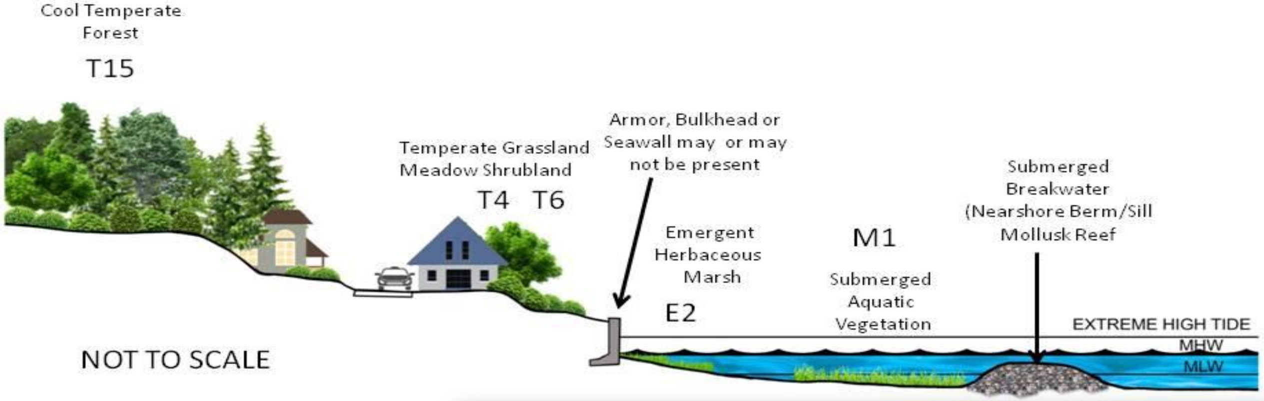
Platform elevation

Natural and Nature-Based Features Evaluation and Implementation Framework



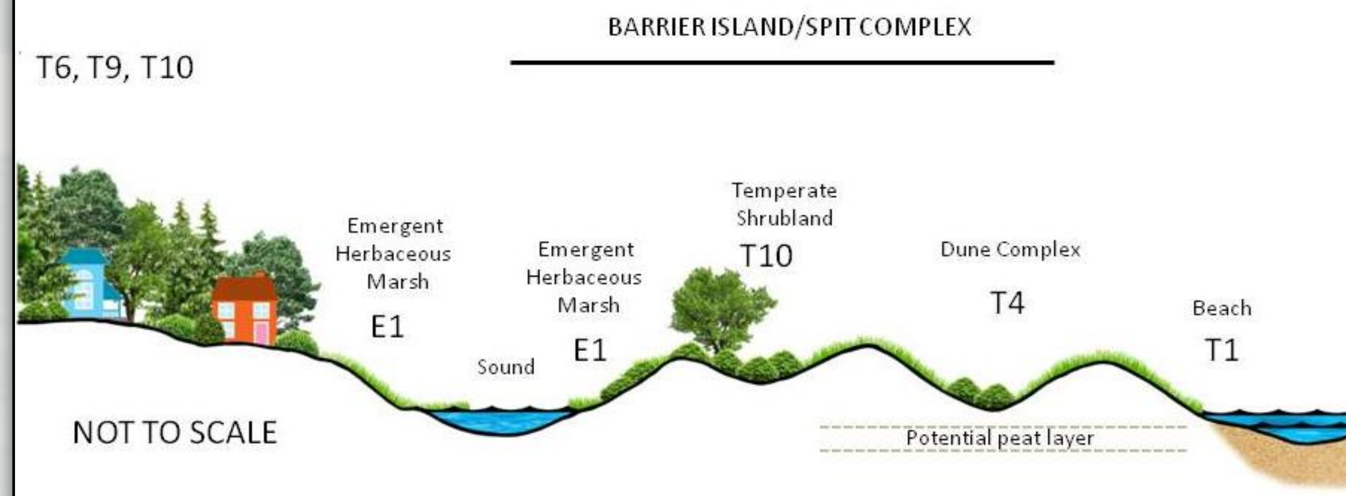
1 A 1-1. Drowned River Valley

Examples: Chesapeake and Delaware Bays

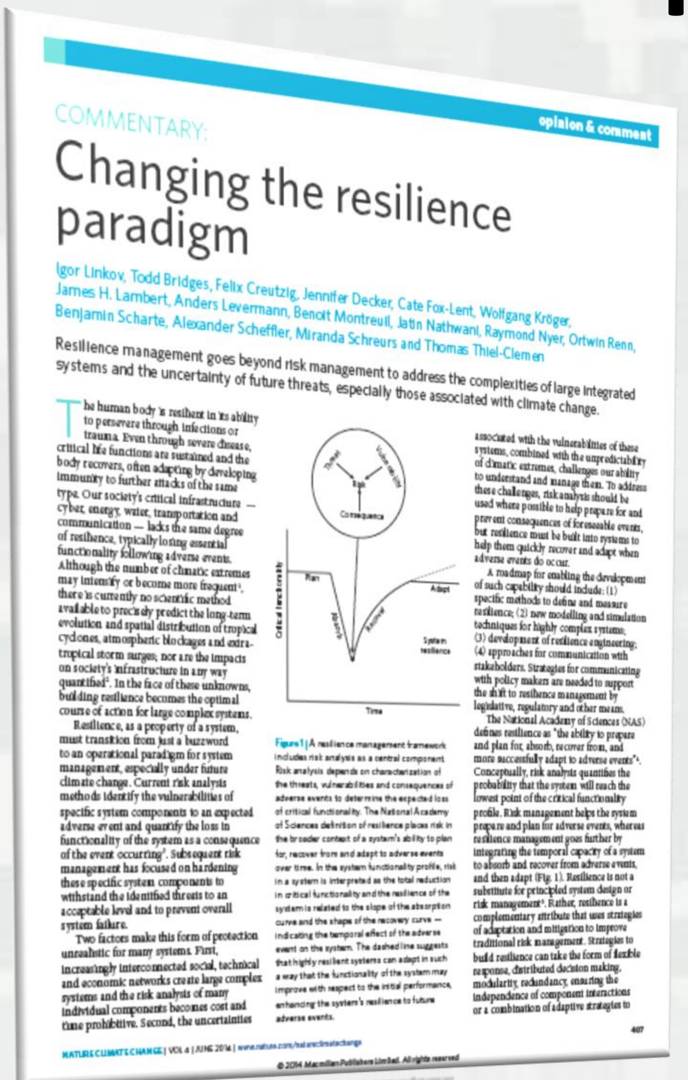


II B 1. Marine Depositional Barrier Coast

Examples: Virginia coast



Resilience

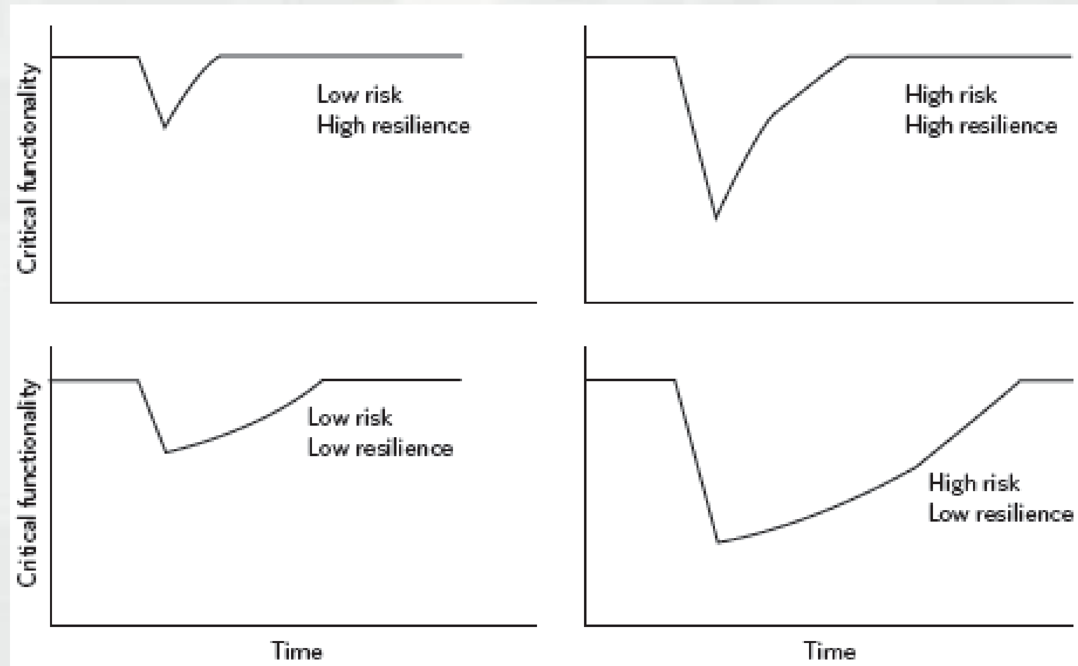

opinion & comment

COMMENTARY:

Changing the resilience paradigm

Igor Linkov, Todd Bridges, Felix Creutzig, Jennifer Decker, Cate Fox-Lent, Wolfgang Kröger, James H. Lambert, Anders Levermann, Benoit Montreuil, Jatin Nathwani, Raymond Nyer, Ortwin Renn, Benjamin Scharte, Alexander Scheffler, Miranda Schreurs and Thomas Thiel-Clemen

Resilience management goes beyond risk management to address the complexities of large integrated systems and the uncertainty of future threats, especially those associated with climate change.



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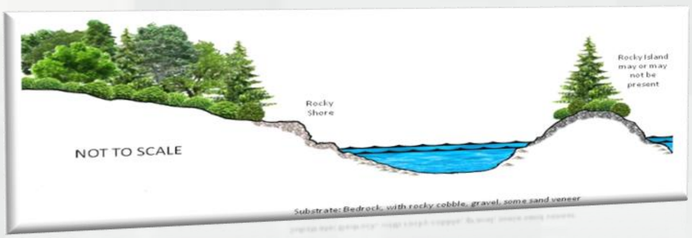
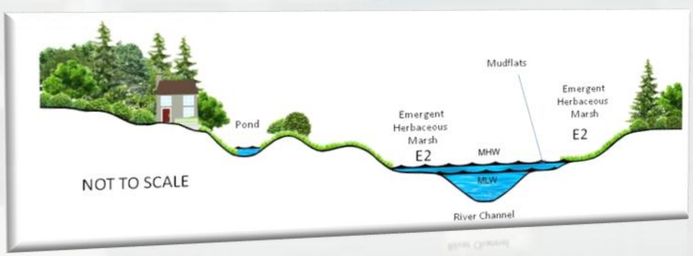
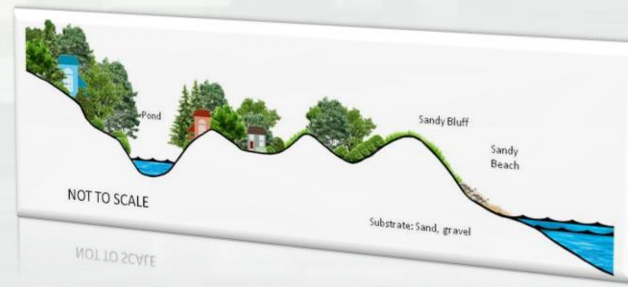
Vulnerability

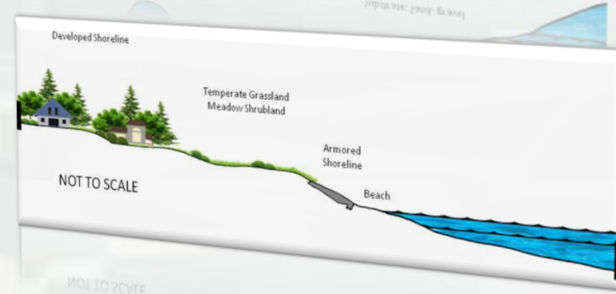
Vulnerability wrt Nature-Based Features in the Coastal Zone





Relative vulnerability of coastal landscapes; how nature-based features affect vulnerability



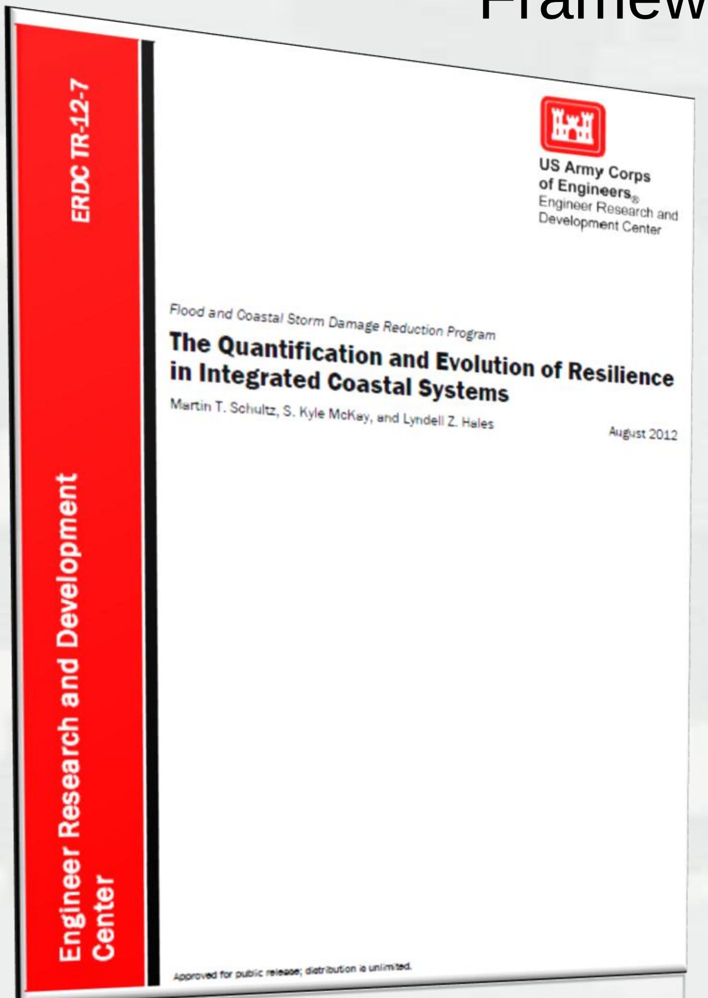


Vulnerability: Degree to which a system is susceptible to, and unable to cope with, adverse effects from a hazard; vulnerability is a function of the character and magnitude of a hazard to which a system is exposed, its sensitivity, and its adaptive capacity.

Wamsley et al. 2013 (in review)

Resilience

Framework to <u>quantify</u> resilience for Integrated Coastal Systems (ICS)


ERDC TR-12-7

Engineer Research and Development Center

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Flood and Coastal Storm Damage Reduction Program

The Quantification and Evolution of Resilience in Integrated Coastal Systems

Martin T. Schultz, S. Kyle McKay, and Lyndell Z. Hales

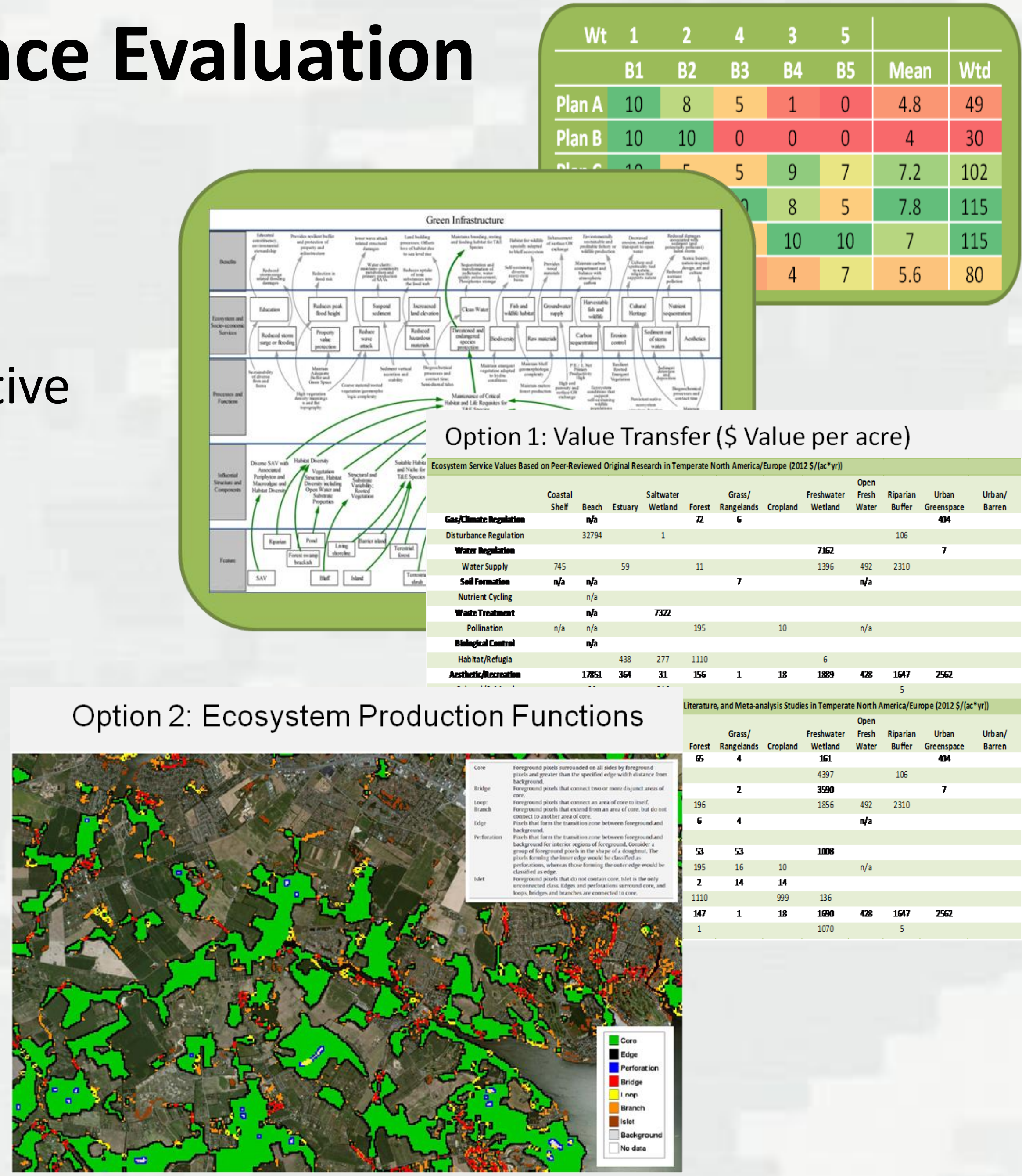
August 2012

Approved for public release; distribution is unlimited.

- Focus on functional performance of engineered projects.
- Incorporates multiple projects in the ICS.
- Develops a quantified measure of resilience based on speed and magnitude of restoring functionality or service following a disturbance.
- Functionality/service can be restored via **natural processes** and/or human maintenance.
- Not limited by mission area.

System Performance Evaluation

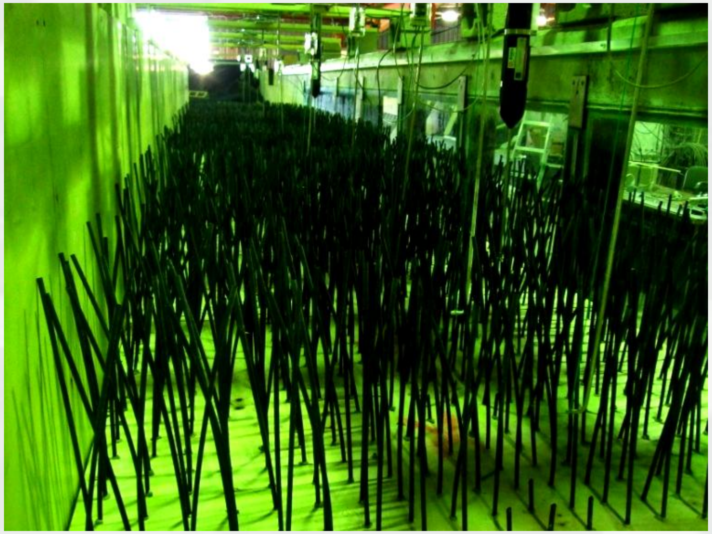
- **Level 1** – Qualitative characterization of performance
- **Level 2** – Semi-quantitative characterization of performance
- **Level 3** – Quantitative characterization of performance

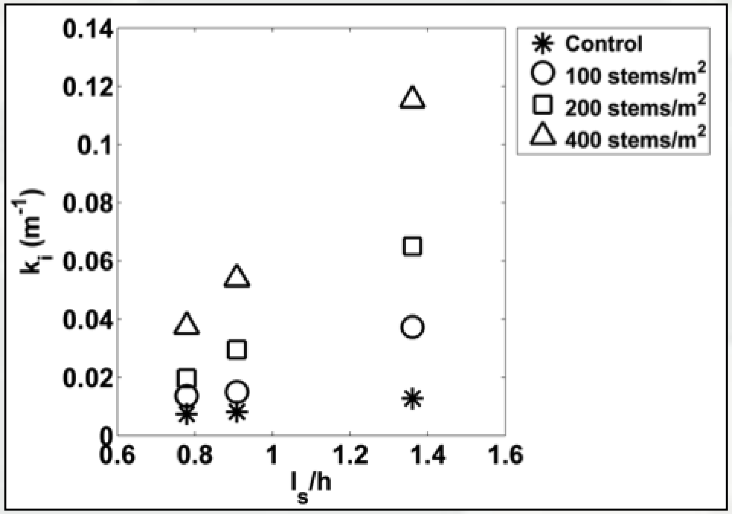


72 individual performance metrics identified for NNBF

Example: Wave Dampening by Wetlands

- What are the engineering benefits of wetlands with respect to waves?
- Flume studies being performed in the 10 ft flume
  - Complemented by examination of sediment processes and field studies
- Wave attenuation was found to:
  - increase with stem density
  - increase with submergence ratio
  - slight increase with incident wave height
- Results used to update STWAVE





Assessing vulnerability and resilience over the long term: performance metrics

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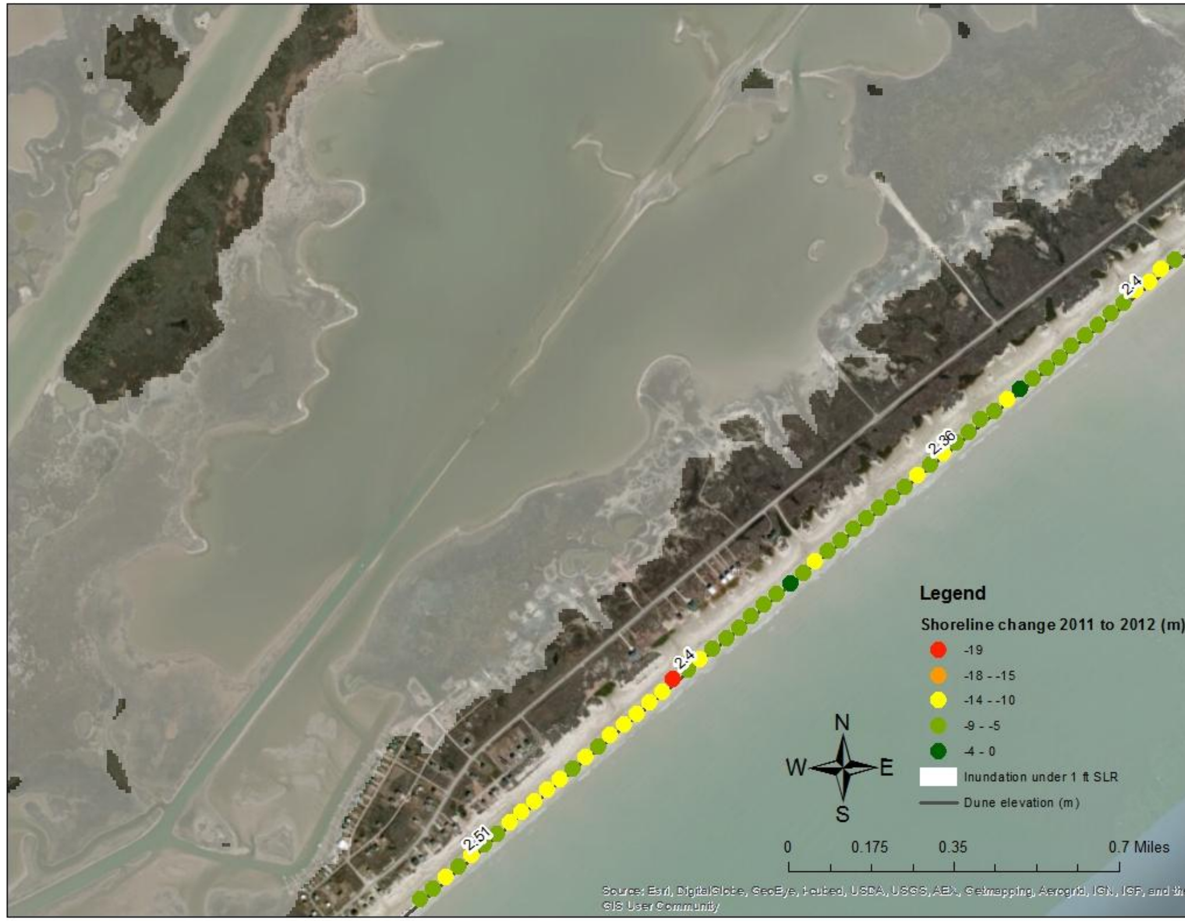
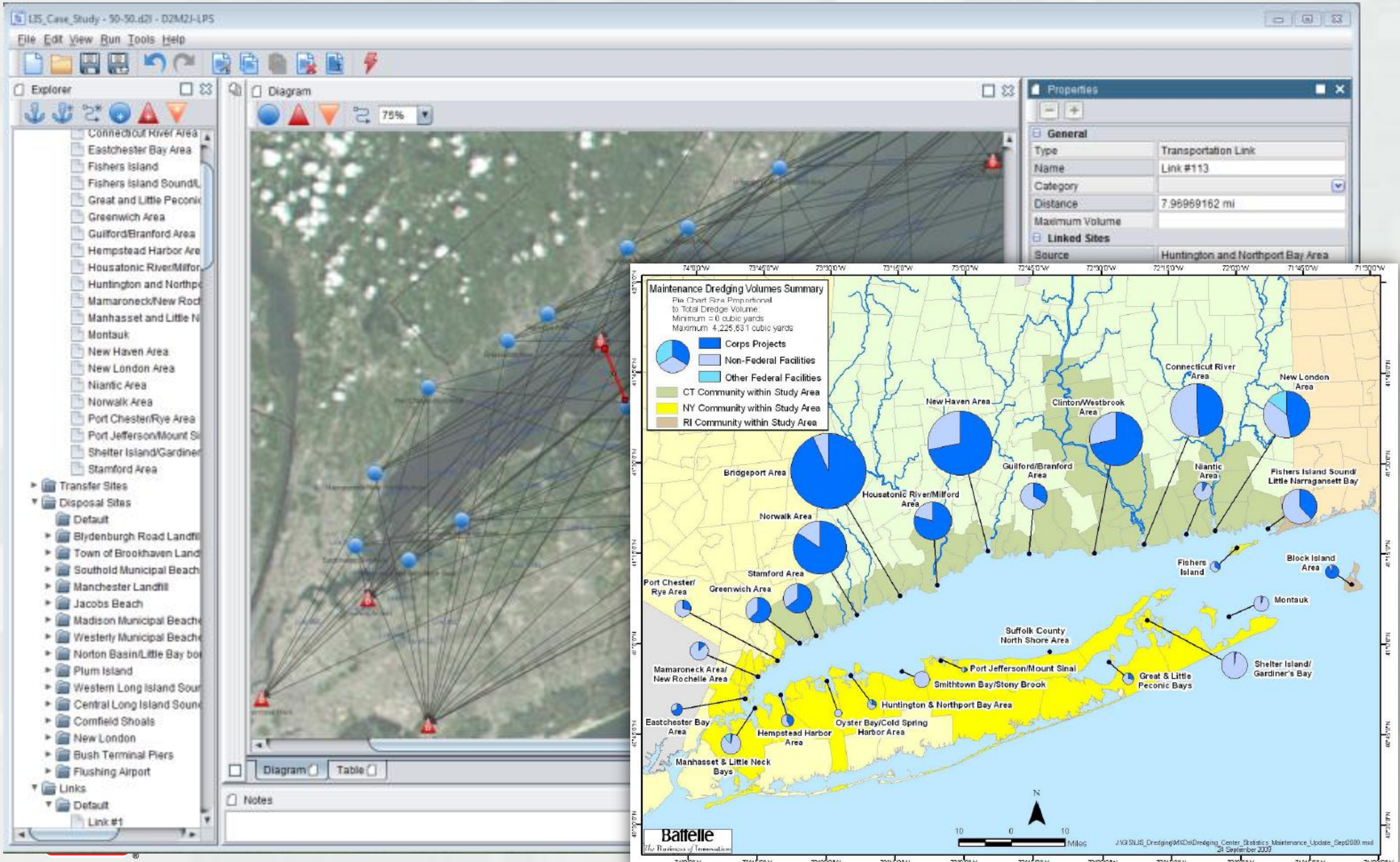


Inundated under 1 ft of RSLR

Drum Bay, Follets Island

D2M2: Dredged Material Management Decisions



Innovative solutions for a safer, better world

Performance Evaluation Case Studies

- **Proof of concept analysis**
  - Quantify benefits of environmental restoration projects using an ecosystem goods and services (EGS) analysis framework
- **Hurricane Sandy case study**
  - Use extreme event to improve understanding of restoration effectiveness & benefits
- **Focused on two general types of services:**
  - Flood damage Reduction
  - Wildlife Habitat (emphasis on T&E species)
- **3 Study Sites**
  - Jamaica Bay
  - Cape May Meadows
  - Cape Charles South

Moving Forward. . .

- Organize and expand science and engineering related to natural processes and features
  - Reduce uncertainties regarding design and performance of NNBF
  - Understand dynamic performance of NNBF
  - How to effectively integrate NNBF with other measures
- Integrating expertise across disciplines and organizations
  - Planning, designing, constructing, operating, monitoring, and maintaining <u>integrated</u> <u>systems</u>